

AD-A031 499

TRI-CON ASSOCIATES INC CAMBRIDGE MASS

F/G 9/5

ELECTRONIC SUBSYSTEM FOR NORMAL INCIDENCE ULTRAVIOLET SPECTROME--ETC(U)

SEP 76 R S HILLS

F19628-74-C-0001

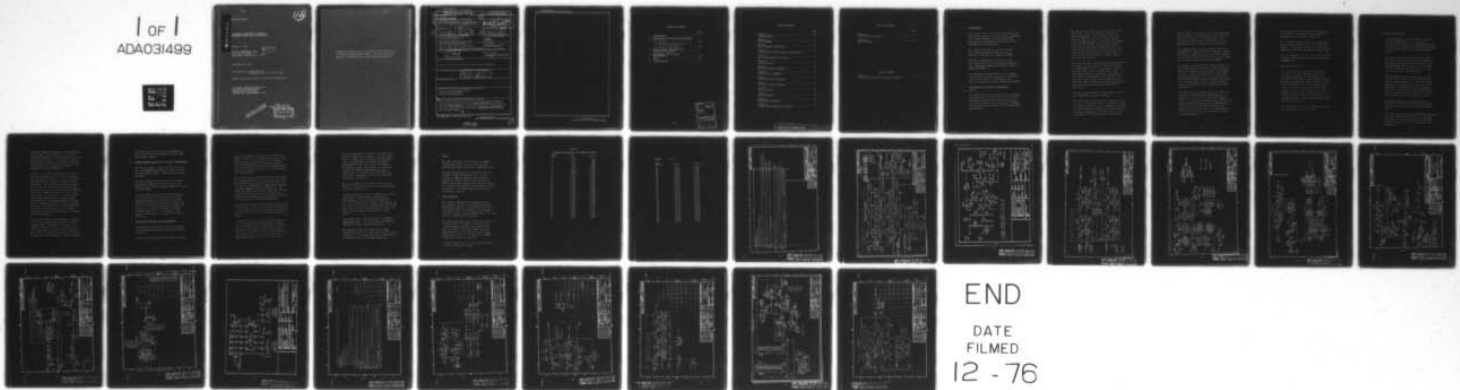
UNCLASSIFIED

C-129

AFGL-TR-76-0206

NL

1 OF 1
ADA031499



END

DATE
FILMED
12 - 76

AD A031499

AFGL-TR-76-0206

ELECTRONIC SUBSYSTEM FOR NORMAL
INCIDENCE ULTRAVIOLET SPECTROMETER

Robert S. Hills

TRI-CON ASSOCIATES, INC.
765 Concord Avenue
Cambridge, Massachusetts 02138

390416

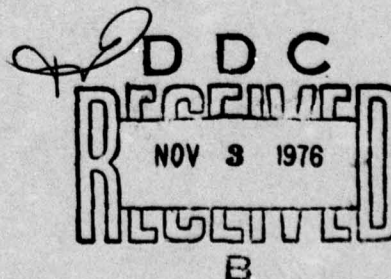
September 10, 1976

Final Report: Period Covered
1 September 1973 to 30 June 1976

Approved for Public Release Distribution Unlimited

AIR FORCE GEOPHYSICS LABORATORY
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
HANSCOM AFB, MASSACHUSETTS 01731

Copy available to DDC does not
permit fully legible reproduction



Qualified requestors may obtain additional copies from the Defense Documentation Center. All others should apply to the National Technical Information Service

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

19 REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. PERFORMING ORG. REPORT NUMBER
AFGL-TR-76-0206		
4. TITLE (and Subtitle)		5. TYPE OF REPORT & PERIOD COVERED
ELECTRONIC SUBSYSTEM FOR NORMAL INCIDENCE ULTRAVIOLET SPECTROMETER.		Final Report; 1 September 1973 - 30 June 1976
6. AUTHOR(s)		7. PERFORMING ORG. REPORT NUMBER
Robert S. Hills		C-129
8. CONTRACT OR GRANT NUMBER(s)		9. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
F19628-74-C-0001		62101F 66880601
10. PERFORMING ORGANIZATION NAME AND ADDRESS		11. REPORT DATE
TRI-CON ASSOCIATES, INC. 765 Concord Avenue Cambridge, Massachusetts 02138		September 1, 1976
12. CONTROLLING OFFICE NAME AND ADDRESS		13. NUMBER OF PAGES
Air Force Geophysics Laboratory Hanscom AFB, Massachusetts 01731 Contract Monitor: Charles W. Chagnon/LKO		28
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report)
(12) 33p.		Unclassified
16. DISTRIBUTION STATEMENT (of this Report)		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
Approved For Public Release, Distribution Unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
(14) C-129		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)		
Normal Incidence Spectrometer Electron Spectrometer Electronics Subsystem		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)		
This report describes the design, fabrication and launch of an electronics subsystem for a normal incidence ultraviolet grating spectrometer for sounding rockets. It also describes an electronics subsystem built for an electron spectrometer which was launched as an auxiliary experiment carried by the grating spectrometer.		

DD FORM 1 JAN 73 1473

EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

390446

1/B

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)



UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

TABLE OF CONTENTS

	Page
1. INTRODUCTION.	1
2. ELECTRONICS FOR GRATING SPECTROMETER	
2.1 General.	1-4
2.2 Physical Configuration.	4
2.3 Circuit Description	5-7
3. GROUND SUPPORT EQUIPMENT FOR GRATING SPECTROMETER.	7
4. ELECTRONICS FOR ELECTRON SPECTROMETER.	7-9
5. TESTS.	10
6. FIELD SERVICES.	10

ACCESSION for		
NTIS	White Section	<input checked="" type="checkbox"/>
DOC	Buff Section	<input type="checkbox"/>
UNANNOUNCED		
JUSTIFICATION		
BY		
DISTRIBUTION/AVAILABILITY CODES		
Dist.	AVAIL. and/or SPECIAL	
A		

LIST OF FIGURES

	Page
FIGURE 1.	13
Timing Diagram	
FIGURE 2.	14
Block Diagram	
FIGURE 3.	15
Pulse Amplifier Schematic	
FIGURE 4.	16
Photon Counter/Shift Register Schematic	
FIGURE 5.	17
Motor Drive/Readout Schematic	
FIGURE 6.	18
Timer Schematic	
FIGURE 7.	19
P.S./Test/Output Schematic	
FIGURE 8.	20
Filter Drive Schematic	
FIGURE 9.	21
Attenuator Drive Schematic	
FIGURE 10	22
Thirteen Display Schematic	
FIGURE 11	23
Timing Diagram	
FIGURE 12	24
Timer Schematic	
FIGURE 13	25
Test/Output Schematic	
FIGURE 14	26
Counter/Shift Register Schematic	

LIST OF FIGURES

	Page
FIGURE 15	27
Step Generator Schematic	
FIGURE 16	28
Block Diagram	

LIST OF TABLES

TABLE I.	11 & 12
Electron Spectrometer #2 Ladder Voltages	

1. INTRODUCTION

This report covers the design, fabrication, and checkout and launch of the electronics subsystem for the RS-61 normal incidence, UV grating spectrometer including the electronics for an auxiliary electron analyzer.

The personnel who worked on this contract were Chester G. Kuczun, Robert S. Hills, Norbert F. Robertie, and Timothy A. Doyle.

The RS-61 spectrometer, exclusive of the electronics, was built by Comstock & Wescott, Inc., Cambridge, Massachusetts under contract F19628-74-C-0002.

An electronics system similar to the system described in this report was built for Spectrometer RM 58II under a subcontract from Comstock & Wescott (Contract F19628-72-C-0254).

2. ELECTRONICS FOR GRATING SPECTROMETER

2.1 General

The function of the electronics for the grating spectrometer is to count pulses from a photomultiplier which produces pulses for photons hitting its cathode, and to control a stepping motor which scans wavelength in the Fastie-Ebert Spectrometer.

The spectrometer steps at the rate of 224 steps per second. Thirteen steps are required to scan one Angstrom. The instrument scans from 1700 Å to 3500 Å. The time for each step is 4.464 milliseconds and is controlled by a crystal clock to 0.01 percent. The photomultiplier output pulses are counted during all except the first 15 microseconds of the step time or 4.449 milliseconds. The initial 15 microseconds is used to transfer the count to a shift register and reset the counters.

The count data and wavelength step identification is connected to a telemetry format consisting of a PCM frame of three 16 bit words. The first word is a sync word, the second word is the wavelength position in Angstroms represented by four binary coded decimal digits and the third word (four digit binary coded decimal) is the totalized count of the photon pulses during 4.449 milliseconds at the wavelength indicated in second word.

A timing diagram showing the PCM format and how it is generated is given in Figure 1.

The 16 bit sync word is used by a computer in the reduction of the flight data. A console built on a previous contract is used to display the output of the instrument during testing, calibration, and pre-launch operation. It is also used to give a quick look at the flight data by producing an

analog output of the photon count rate from real time telemetry or tape playback. This console's decoding electronics is synchronized to the instrument's data train by detecting the high amplitude bits at the start of the sync word.

The stepping motor has four windings which are energized in a specific sense to produce rotation. It rotates 90 degrees per step and thus requires four different logic sequences which are generated and controlled by the electronics system.

In addition to the functions described above, the electronics subsystem includes a pulse amplifier, test pulse generator, high voltage power supply system, a filter actuation/drive circuit which inserts a background filter in the photon beam at 1900 Å and 2400 Å and an attenuator actuation/drive circuit which inserts a neutral density filter in the photon beam at wavelengths longer than 1943 Å.

The PCM data were brought through the interface connector and modulated an IRIG channel H subcarrier oscillator in the S band telemetry deck. This subcarrier channel, when operated for maximum frequency response, had a minimum rise time of 14 microseconds which is more than sufficient for transmission of the PCM signal with a non return to zero form and a bit width of 93 microseconds.

Voltage monitors were brought out to the interface connector and commutated by a TRI-CON commutator onto subcarrier channel 10.

The instrument operated on a 28.8 volt sealed nickel cadmium battery with a one ampere hour capacity. Instrument current was less than 0.7 amperes for less than 10 minutes during flight.

All the integrated circuit logic was of the complementary symmetry, metal oxide semiconductor (COSMOS) type.

2.2 Physical Configuration

The electronic system was made up of three sections: the pulse amplifier located on the detector assembly at the front of the instrument, six digital logic cards which were located in a card rack integral with the rear of the instrument, and a high voltage power supply and card located in the center of the housing. A dual (+13V, -13V) low voltage regulated power supply was mounted on one of the digital logic cards. All electronics was integral with the housing. The card rack was vented to the outside.

The instrument electrical interface connectors were hard mounted to the housing.

2.3 Circuit Description

A block diagram of the instrument electronics is given in Figure 2. It is similar to the electronic system in the RM 58II instrument except for the addition of the background filter circuit and deletion of the solar photometer circuits.

The pulses from the pulse amplifier, Figure 3 are fed to the photon counter card, Figure 4. The binary-coded-decimal output from the four counting stages was transferred to the two 8 bit shift registers and shifted out as word three in the three word PCM frame.

The wavelength scanner position was counted in four decade counters on the Motor Drive/Readout card, transferred to two 8 bit shift registers and shifted out as word two in the PCM frame. A schematic is given in Figure 5. The end of scan is detected by limit switches which reverse the motor direction and at the low end also set the scan counts to 1700.

The logic circuits for driving the four position motor were included with the scanner position circuits on the Motor Drive/Readout card.

The timer card contained the PCM clock oscillator and logic circuits to generate the necessary sync pulse, shift pulses, load, inhibit, and counter reset signals. A schematic is shown in Figure 6.

The Power Supply/Test/Output card included the low voltage $\pm 15V$ converters, a test pulse generator operating at 25,000 pulses per second, load, reset, and motor trigger pulse circuits, and circuits to process the PCM data into the form required for feeding the telemetry. A schematic is given in Figure 7.

Circuits on the Filter Drive/13 card actuate a solenoid to insert a filter into the photon beam for one second when the scan is at 1900 Å and 2400 Å and is scanning towards a longer wavelength. The scan motor is stopped during the one second. The 1900 Å and 2400 Å scan readings are detected on the Motor Drive/Readout card and a trigger transferred to the filter card. Also, on this card is a circuit which counts every thirteenth motor step trigger and advances the wavelength register one Angstrom. A binary output of four bits counting 0 through 12 is picked off of this circuit and fed to the control console to be displayed along with the indicated Angstroms. A schematic is shown in Figure 8.

The Attenuator Drive card energizes a solenoid to insert the neutral density filter at wavelengths longer than 1943 Å. The scan shift register setting of 1944 is detected and sets a flip-flop when the wavelength is scanning up and resets the flip-flop when 1944 is passed on the way down. The schematic is given in Figure 9.

The logic cards are similar in appearance to those shown in the photographs in report AFGL-TR-74-0397 on RM 58.

3. GROUND SUPPORT EQUIPMENT FOR GRATING SPECTROMETER

The control console originally built for use with the RM 58II instrument was used to control the RS-61 Spectrometer. Some modification was necessary.

The most significant digit of the five digit wavelength display was blanked out and the remaining four digits displayed Angstroms directly (1700 to 3500).

A new two digit display was added to indicate the thirteen motor steps required for each Angstrom change. This indicator was driven from a new circuit card which was added to the console. It contained circuits to change the level of the 4 binary bits from the flight equipment from 13V to 5V and convert from binary to BCD coding. A schematic is shown in Figure 10.

4. ELECTRONICS FOR ELECTRON SPECTROMETER

An electronic subsystem was built to energize the Government furnished electron spectrometer detector.

The electronics generated 64 different voltages

which were applied in sequence to the detector plates. The electrons collected at each voltage (energy level) were multiplied in a channel electron multiplier in the detector assembly and the current bursts (each burst representing one electron) were counted in a 4 decade decimal counter (16 bits).

The 16 bit electron count, along with six binary bits representing the 64 detector voltage levels at which the electrons were collected, and a 16 bit sync word comprised the PCM frame of 48 bits. A timing diagram is given in Figure 11. The frame rate was 50 per second. Thus, the electron collection time for each voltage step was 20 milliseconds (actually 15 microseconds less than 20 milliseconds or 19.985 milliseconds).

The detector voltages range from less than a volt to more than 64 volts and the ratio of successive voltages was held to better than $1/2$ of one percent of 1.06. A table of voltages is given in Table 1.

A high voltage power supply and filter card for the electron multiplier was mounted adjacent to the multiplier. The output pulses from the multiplier were amplified in a pulse amplifier and fed to the counter and logic boards which were located in a box mounted on the side of the RS-61 Spectrometer opposite the bolt circle.

The box contained five printed circuit cards and two low voltage power supplies. The five cards were: a timer card to generate the PCM frame logic; a test/output card which contained a test generator and also circuits to combine the electron count, step number, and sync word to make the complete PCM output waveform; a counter card; a step generator card; and step drive card. Schematics of the cards are given in Figures 12 through 15.

The pulse amplifier is similar to that used in RS-61. A block diagram of the electronic system is given in Figure 16.

A G.S.E. console was used to operate the electron spectrometer system during acceptance and environmental test, calibration integration and in the field prior to launch. The console was also used to decode the electron count and voltage step from the flight magnetic tape for quick look data reduction immediately after the rocket flight.

This console was designed and built by TRI-CON ASSOCIATES, INC., on a subcontract from Comstock & Wescott contract (F19628-73-C-0253.)

The PCM data frame was telemetered on IRIG channels F and 17. The high voltage monitor was on channel 16. In addition the high voltage monitor was commutated by the TRI-CON commutator.

5. TESTS

The RS-61 instrument was delivered to AFGL on 15 September 1975. It was checked per the Test and Acceptance Plan dated 9 September 1975.

The Electron Spectrometer electronics was delivered to AFGL on 30 March 1976. It was checked at AFGL per R&D Test and Acceptance Plan dated 5 April 1976, and mounted on the RS-61 housing and prepared for a vibration test. On 16 April it was vibrated along with the RS-61 instrument at the AFGL vibration facilities. No failures occurred.

6. FIELD SERVICES

The complete instrument was integrated with the pointing control at Ball Brothers Research Corporation, Boulder, Colorado during the week of 26 April 1976. The electronics performed correctly during all integration phases. R. Hills spent the entire week at Boulder.

Pre-launch procedures were carried out the week of 10 May 1976. At WSMR the instrument was launched aboard an Aerobee 150 rocket from B Tower at LC-35 at 1100 hours MDT. Data was obtained from both instruments and the entire payload was recovered. R. Hills was at WSMR 10 May 1976 through 18 May 1976.

A launch report was filed by Comstock & Wescott on Contract F19628-74-C-0002.

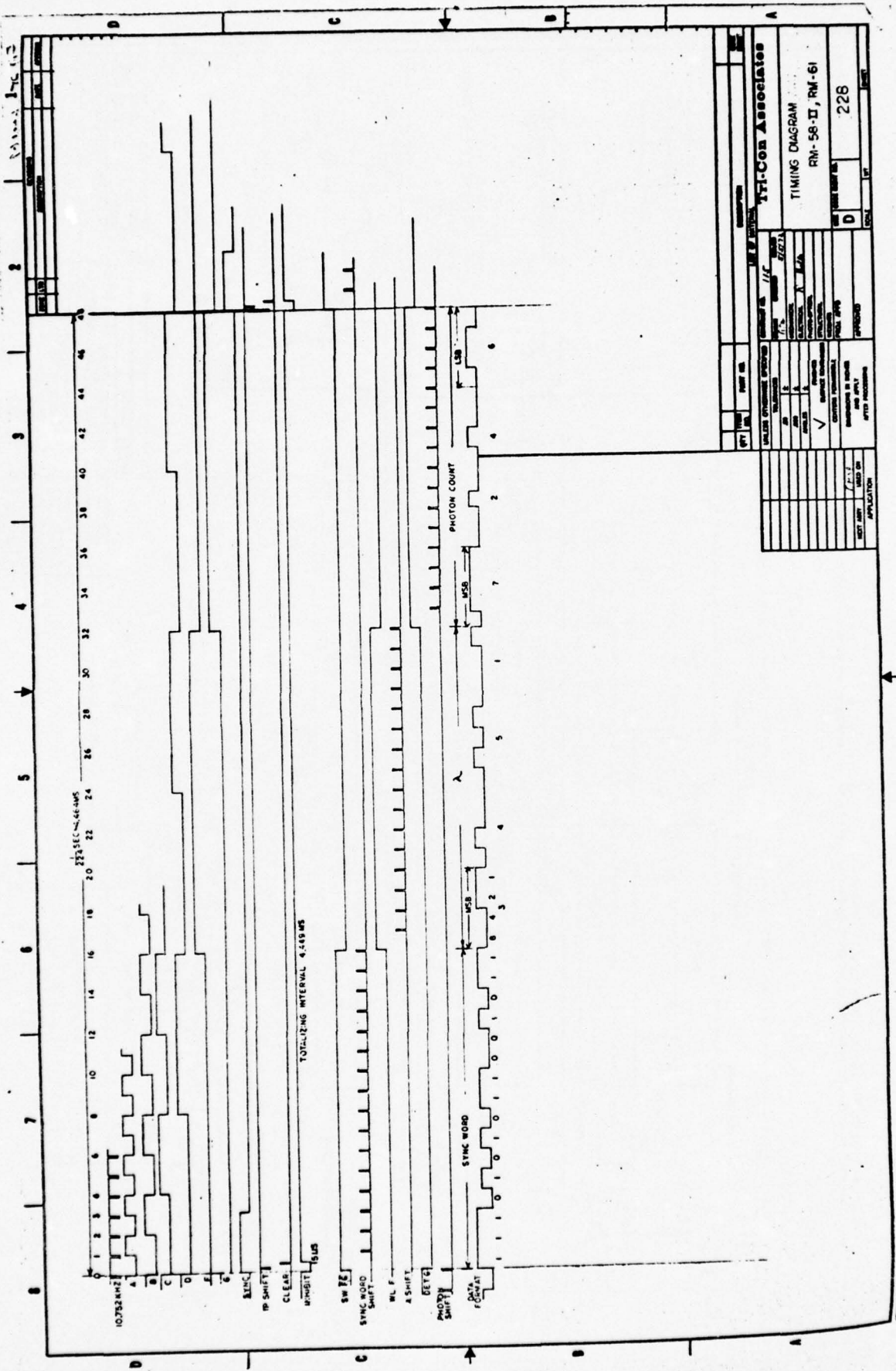
TABLE I

ELECTRON SPECTROMETER #2 LADDER VOLTAGES

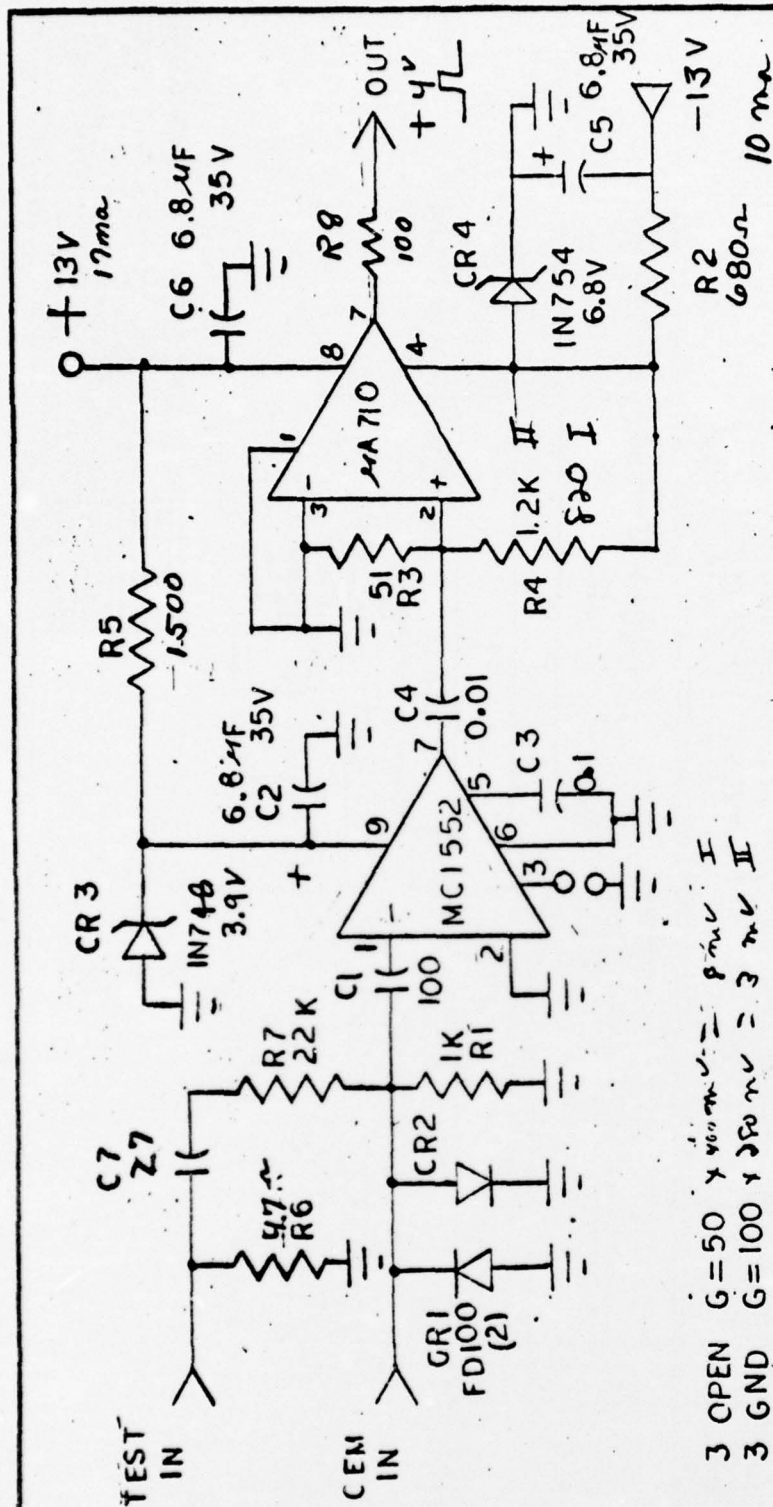
<u>STEP</u>	<u>V+</u>	<u>V-</u>
0	.006	.002
1	.157	.153
2	.320	.316
3	.491	.486
4	.670	.665
5	.862	.857
6	1.068	1.062
7	1.285	1.280
8	1.457	1.451
9	1.546	1.542
10	1.641	1.636
11	1.741	1.736
12	1.848	1.843
13	1.960	1.955
14	2.078	2.073
15	2.204	2.199
16	2.351	2.344
17	2.492	2.486
18	2.645	2.638
19	2.805	2.799
20	2.974	2.966
21	3.154	3.146
22	3.346	3.339
23	3.551	3.543
24	3.764	3.755
25	3.993	3.983
26	4.234	4.224
27	4.486	4.476
28	4.758	4.747
29	5.042	5.031
30	5.341	5.329
31	5.661	5.649
32	6.084	6.068

TABLE I cont'd

<u>STEP</u>	<u>V+</u>	<u>V-</u>
33	6.445	6.430
34	6.837	6.820
35	7.245	7.339
36	7.675	7.657
37	8.135	8.118
38	8.629	8.610
39	9.149	9.132
40	9.680	9.690
41	10.27	10.28
42	10.88	10.89
43	11.53	11.54
44	12.22	12.23
45	12.95	12.96
46	13.71	13.72
47	14.53	14.53
48	15.76	15.76
49	16.70	16.69
50	17.71	17.70
51	18.76	18.75
52	19.87	19.86
53	21.11	21.07
54	22.39	22.34
55	23.73	23.69
56	25.14	25.09
57	26.65	26.59
58	28.24	28.18
59	29.90	29.84
60	31.69	31.62
61	33.56	33.50
62	35.53	35.45
63	37.63	37.56



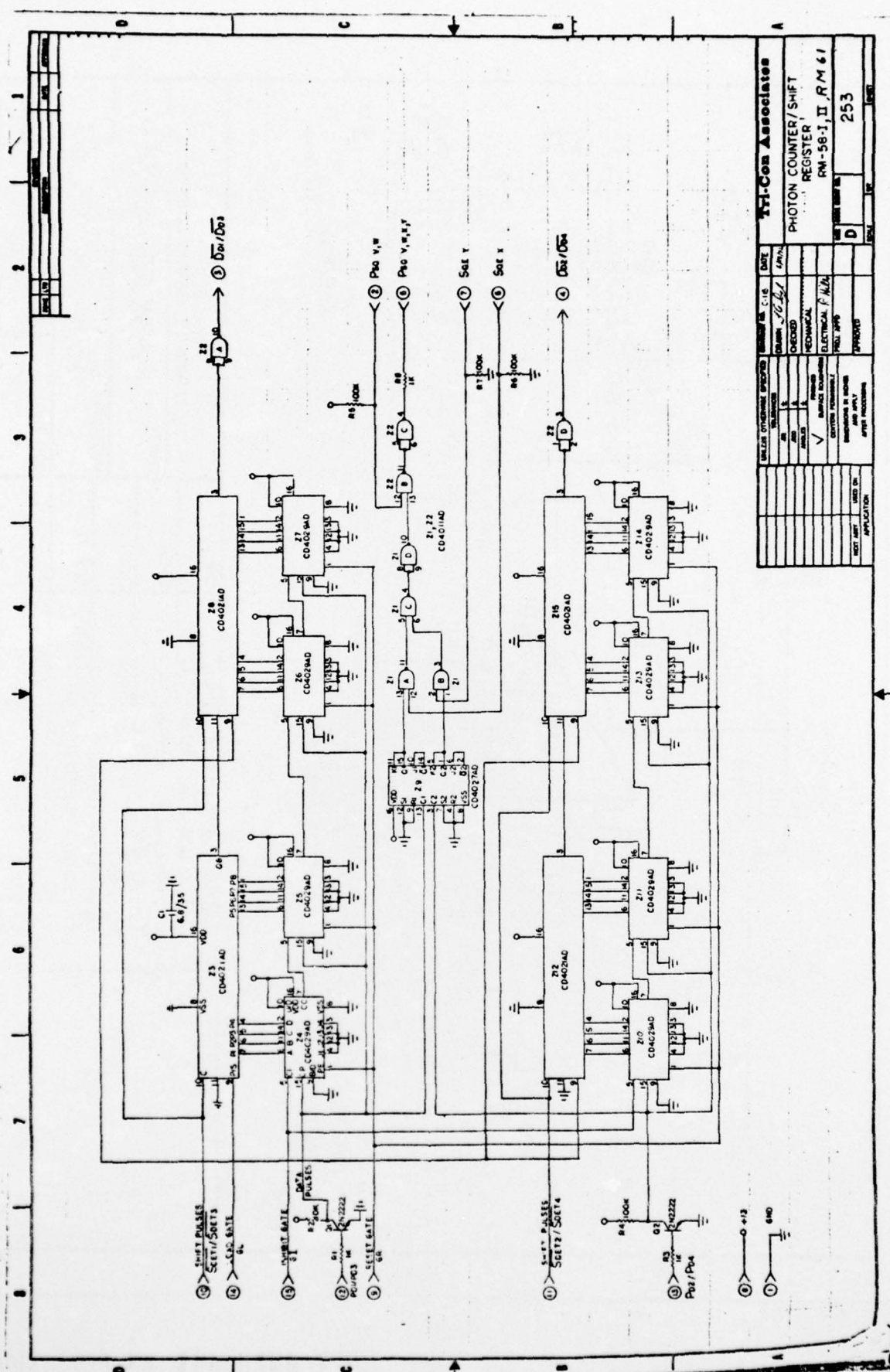
TYI-Con Associates	
TIMING DIAGRAM	
RM-58-II, RM-61	
DATE	228
TIME	
BY	
FOR	
REVISION	
APPROVED	
TEST DATA	
TEST DATE	
TEST TIME	
TEST PLACE	
TEST PERSON	
TEST INSTRUMENT	
TEST METHOD	
TEST RESULT	
TEST CONCLUSION	
TEST SIGNATURE	
TEST DATE	
TEST TIME	
TEST PLACE	
TEST PERSON	
TEST INSTRUMENT	
TEST METHOD	
TEST RESULT	
TEST CONCLUSION	
TEST SIGNATURE	



2.25

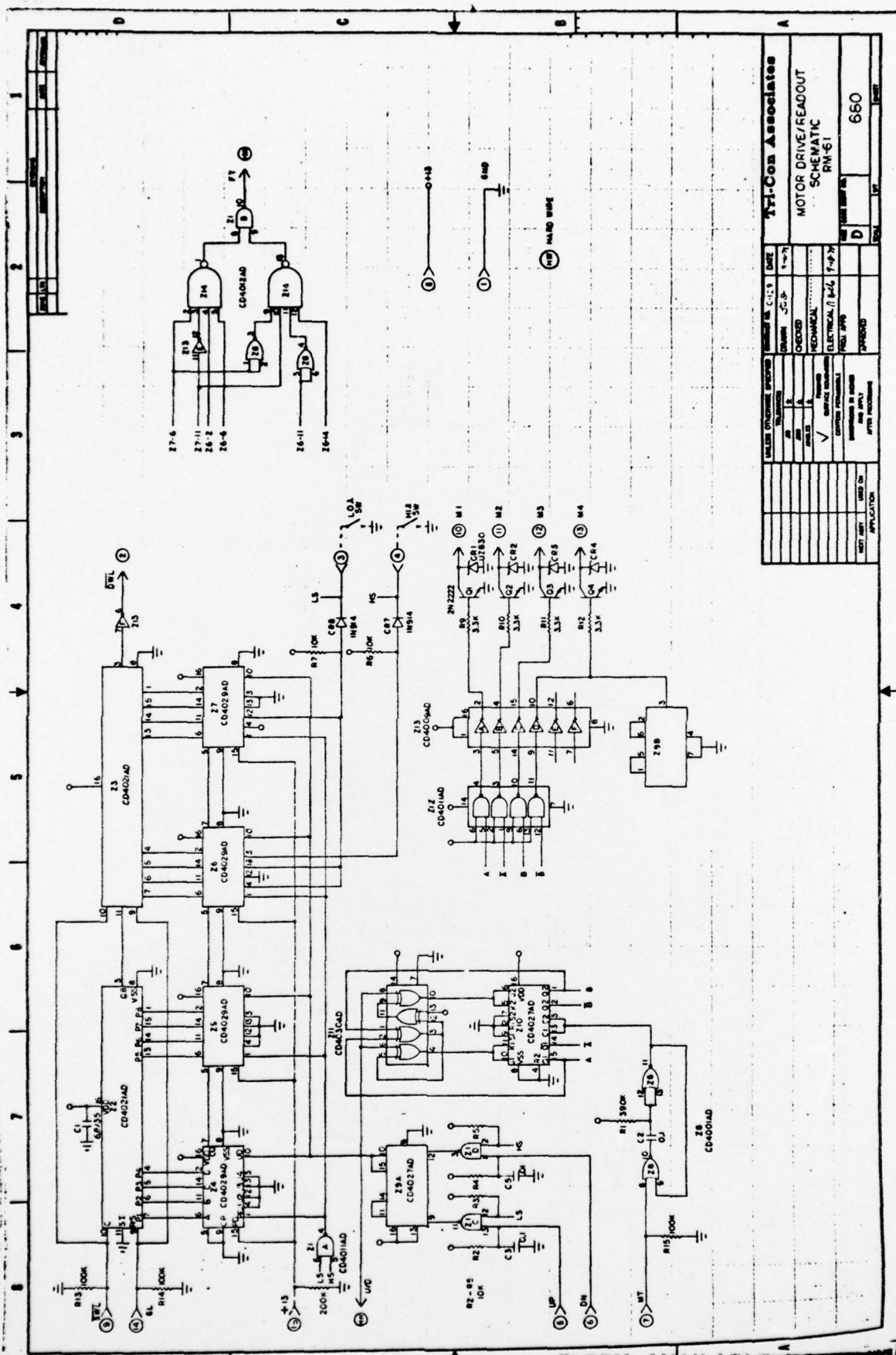
TRI-CON. CAMBRIDGE, MASSACHUSETTS		DATE:	DRN: <i>RST</i>	TOLERANCES UNLESS OTHERWISE SPECIFIED:	REV	REMARKS	DATE
PART: PULSE AMP		DATE:	CAD:	FRACTIONAL $\pm 1/64$			
MATERIAL: RM-58, RS-61		DATE:	APP:	DECIMAL $\pm .005$			
JOB NO: 394		SCALE:	NO. REQ'D: 1257	ANGULAR $\pm 1/4^\circ$			
REV. DWG. NO. A-		FINISH:	SURFACE FINISH 1257	ALL EDGES .005/.010 R			
		NEXT ASSY					

Figure 2.16



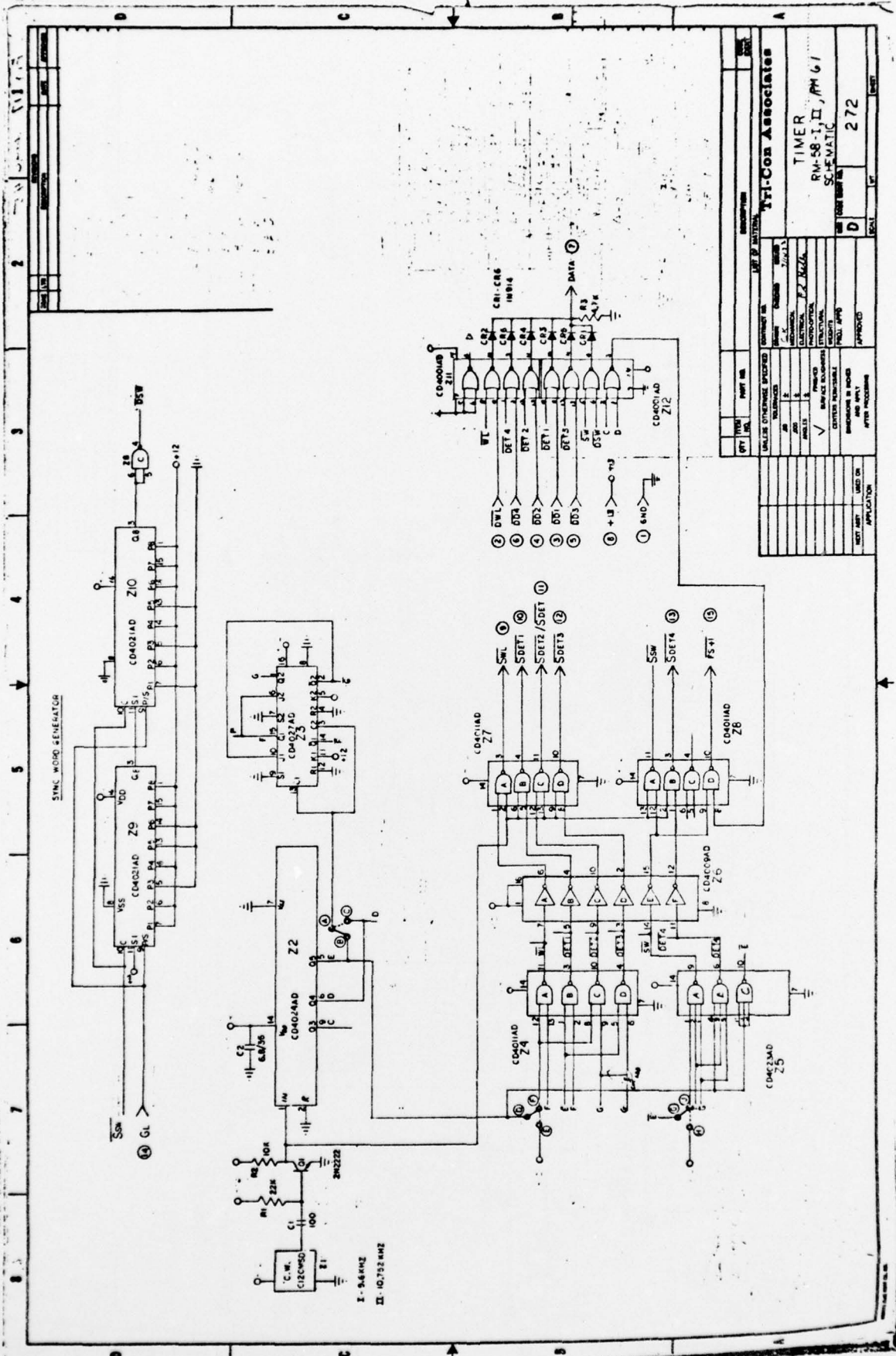
TTL-CON Associates		DATE	REV
PHOTON COUNTER/SHIFT REGISTER		10/27/71	1
RM-58-1, II, RM 41			
D			
253			

COPY AVAILABLE TO DDC DOES NOT PERMIT FULLY LEGIBLE PRODUCTION

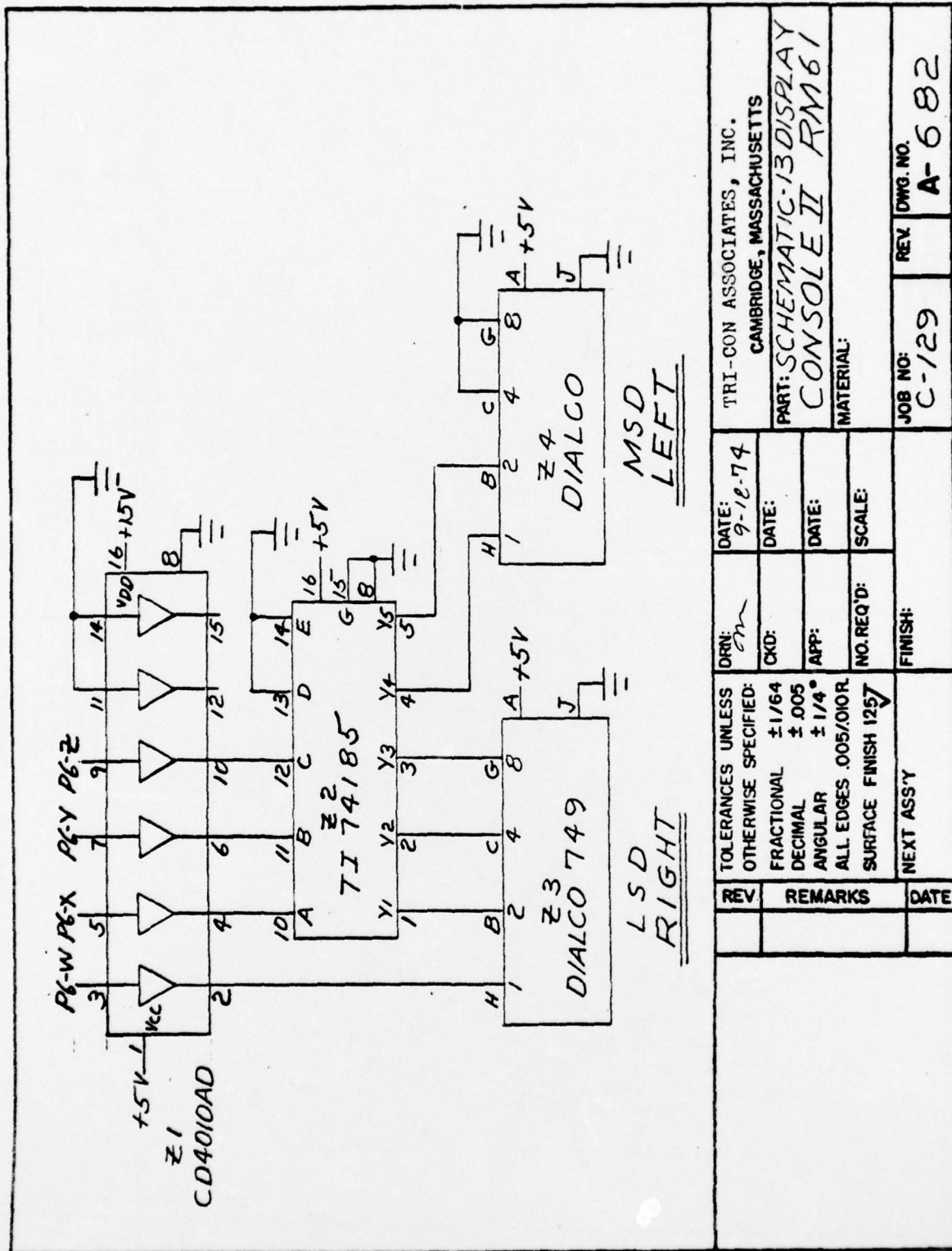


Tri-Con Associates			
DATE	1-7-79	DESIGNED BY	J.C.D.
CHECKED		REVIEWED	
APPROVED		APPROVED	
MOTOR DRIVE/READOUT SCHEMATIC RM-61			
REV	DATE	BY	APP
1	1-7-79	J.C.D.	
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			
38			
39			
40			
41			
42			
43			
44			
45			
46			
47			
48			
49			
50			
51			
52			
53			
54			
55			
56			
57			
58			
59			
60			
61			
62			
63			
64			
65			
66			
67			
68			
69			
70			
71			
72			
73			
74			
75			
76			
77			
78			
79			
80			
81			
82			
83			
84			
85			
86			
87			
88			
89			
90			
91			
92			
93			
94			
95			
96			
97			
98			
99			
100			

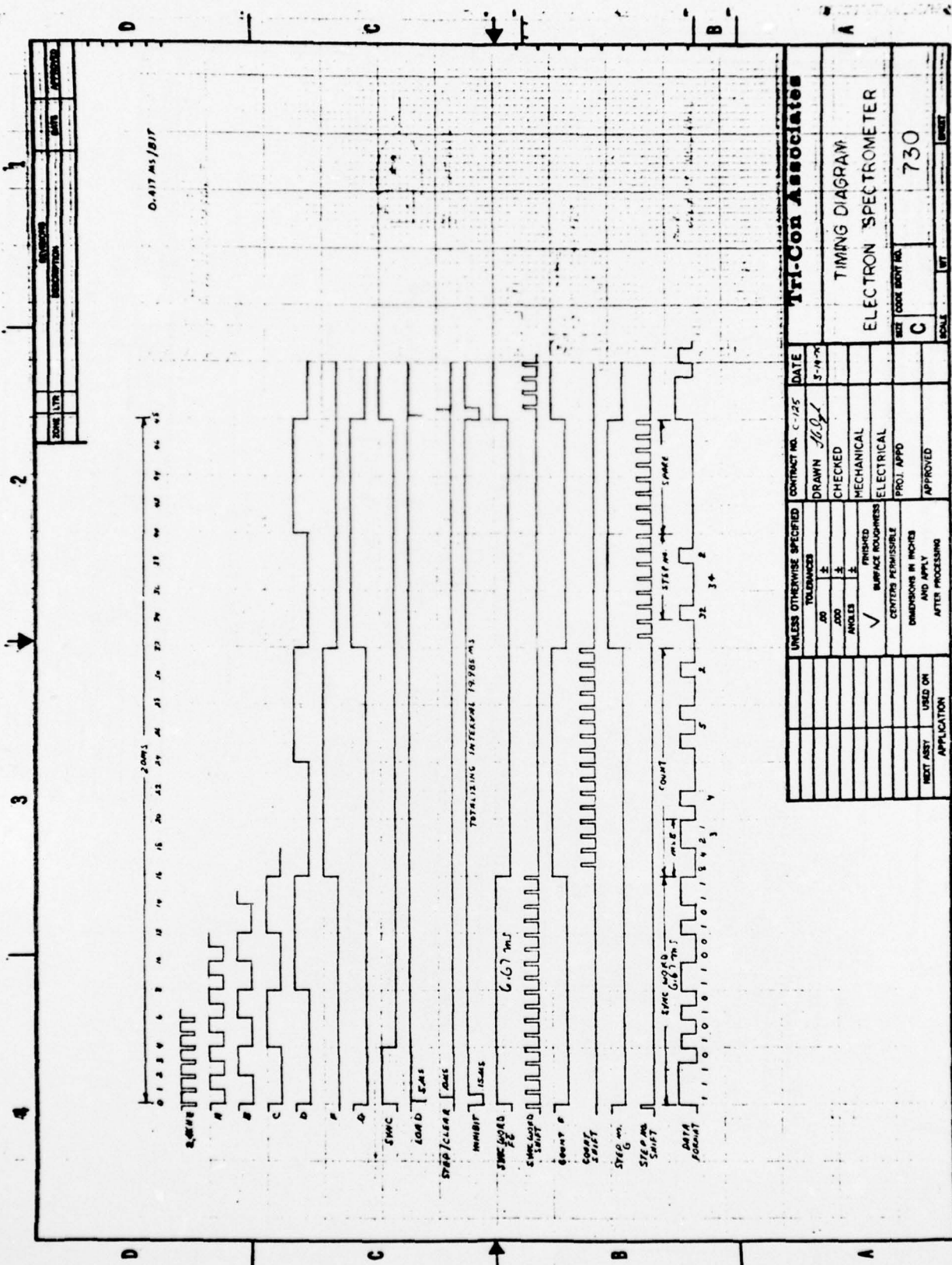
COPY AVAILABLE TO DDC DOES NOT PERMIT FULLY LEGIBLE PRODUCTION



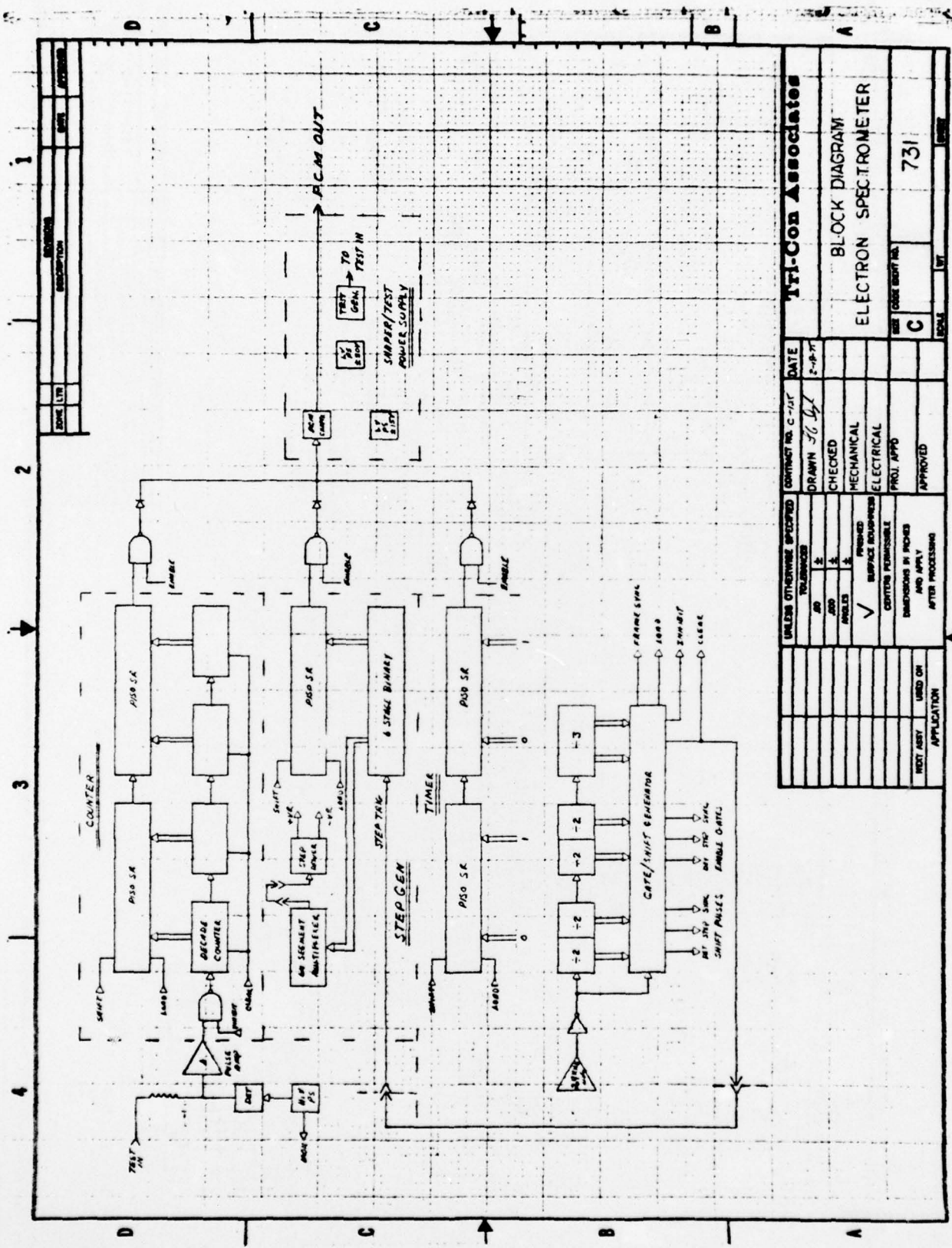
REV. NO.		PART NO.		DESCRIPTION		DATE	
1		4001AD		4001AD		1/1/77	
2		4001B		4001B		1/1/77	
3		4001C		4001C		1/1/77	
4		4001D		4001D		1/1/77	
5		4001E		4001E		1/1/77	
6		4001F		4001F		1/1/77	
7		4001G		4001G		1/1/77	
8		4001H		4001H		1/1/77	
9		4001I		4001I		1/1/77	
10		4001J		4001J		1/1/77	
11		4001K		4001K		1/1/77	
12		4001L		4001L		1/1/77	
13		4001M		4001M		1/1/77	
14		4001N		4001N		1/1/77	
15		4001O		4001O		1/1/77	
16		4001P		4001P		1/1/77	
17		4001Q		4001Q		1/1/77	
18		4001R		4001R		1/1/77	
19		4001S		4001S		1/1/77	
20		4001T		4001T		1/1/77	
21		4001U		4001U		1/1/77	
22		4001V		4001V		1/1/77	
23		4001W		4001W		1/1/77	
24		4001X		4001X		1/1/77	
25		4001Y		4001Y		1/1/77	
26		4001Z		4001Z		1/1/77	
27		4001AA		4001AA		1/1/77	
28		4001AB		4001AB		1/1/77	
29		4001AC		4001AC		1/1/77	
30		4001AD		4001AD		1/1/77	
31		4001AE		4001AE		1/1/77	
32		4001AF		4001AF		1/1/77	
33		4001AG		4001AG		1/1/77	
34		4001AH		4001AH		1/1/77	
35		4001AI		4001AI		1/1/77	
36		4001AJ		4001AJ		1/1/77	
37		4001AK		4001AK		1/1/77	
38		4001AL		4001AL		1/1/77	
39		4001AM		4001AM		1/1/77	
40		4001AN		4001AN		1/1/77	
41		4001AO		4001AO		1/1/77	
42		4001AP		4001AP		1/1/77	
43		4001AQ		4001AQ		1/1/77	
44		4001AR		4001AR		1/1/77	
45		4001AS		4001AS		1/1/77	
46		4001AT		4001AT		1/1/77	
47		4001AU		4001AU		1/1/77	
48		4001AV		4001AV		1/1/77	
49		4001AW		4001AW		1/1/77	
50		4001AX		4001AX		1/1/77	
51		4001AY		4001AY		1/1/77	
52		4001AZ		4001AZ		1/1/77	
53		4001BA		4001BA		1/1/77	
54		4001BB		4001BB		1/1/77	
55		4001BC		4001BC		1/1/77	
56		4001BD		4001BD		1/1/77	
57		4001BE		4001BE		1/1/77	
58		4001BF		4001BF		1/1/77	
59		4001BG		4001BG		1/1/77	
60		4001BH		4001BH		1/1/77	
61		4001BI		4001BI		1/1/77	
62		4001BJ		4001BJ		1/1/77	
63		4001BK		4001BK		1/1/77	
64		4001BL		4001BL		1/1/77	
65		4001BM		4001BM		1/1/77	
66		4001BN		4001BN		1/1/77	
67		4001BO		4001BO		1/1/77	
68		4001BP		4001BP		1/1/77	
69		4001BQ		4001BQ		1/1/77	
70		4001BR		4001BR		1/1/77	
71		4001BS		4001BS		1/1/77	
72		4001BT		4001BT		1/1/77	
73		4001BU		4001BU		1/1/77	
74		4001BV		4001BV		1/1/77	
75		4001BW		4001BW		1/1/77	
76		4001BX		4001BX		1/1/77	
77		4001BY		4001BY		1/1/77	
78		4001BZ		4001BZ		1/1/77	
79		4001CA		4001CA		1/1/77	
80		4001CB		4001CB		1/1/77	
81		4001CC		4001CC		1/1/77	
82		4001CD		4001CD		1/1/77	
83		4001CE		4001CE		1/1/77	
84		4001CF		4001CF		1/1/77	
85		4001CG		4001CG		1/1/77	
86		4001CH		4001CH		1/1/77	
87		4001CI		4001CI		1/1/77	
88		4001CJ		4001CJ		1/1/77	
89		4001CK		4001CK		1/1/77	
90		4001CL		4001CL		1/1/77	
91		4001CM		4001CM		1/1/77	
92		4001CN		4001CN		1/1/77	
93		4001CO		4001CO		1/1/77	
94		4001CP		4001CP		1/1/77	
95		4001CQ		4001CQ		1/1/77	
96		4001CR		4001CR		1/1/77	
97		4001CS		4001CS		1/1/77	
98		4001CT		4001CT		1/1/77	
99		4001CU		4001CU		1/1/77	
100		4001CV		4001CV		1/1/77	
101		4001CW		4001CW		1/1/77	
102		4001CX		4001CX		1/1/77	
103		4001CY		4001CY		1/1/77	
104		4001CZ		4001CZ		1/1/77	
105		4001DA		4001DA		1/1/77	
106		4001DB		4001DB		1/1/77	
107		4001DC		4001DC		1/1/77	
108		4001DD		4001DD		1/1/77	
109		4001DE		4001DE		1/1/77	
110		4001DF		4001DF		1/1/77	
111		4001DG		4001DG		1/1/77	
112		4001DH		4001DH		1/1/77	
113		4001DI		4001DI		1/1/77	
114		4001DJ		4001DJ		1/1/77	
115		4001DK		4001DK		1/1/77	
116		4001DL		4001DL		1/1/77	
117		4001DM		4001DM		1/1/77	
118		4001DN		4001DN		1/1/77	
119		4001DO		4001DO		1/1/77	
120		4001DP		4001DP		1/1/77	
121		4001DQ		4001DQ		1/1/77	
122		4001DR		4001DR		1/1/77	
123		4001DS		4001DS		1/1/77	
124		4001DT		4001DT		1/1/77	
125		4001DU		4001DU		1/1/77	
126		4001DV		4001DV		1/1/77	
127		4001DW		4001DW		1/1/77	
128		4001DX		4001DX		1/1/77	
129		4001DY		4001DY		1/1/77	
130		4001DZ		4001DZ		1/1/77	
131		4001EA		4001EA		1/1/77	
132		4001EB		4001EB		1/1/77	
133		4001EC		4001EC		1/1/77	
134		4001ED		4001ED		1/1/77	
135		4001EE		4001EE		1/1/77	
136		4001EF		4001EF		1/1/77	
137		4001EG		4001EG		1/1/77	
138		4001EH		4001EH		1/1/77	
139		4001EI		4001EI		1/1/77	
140		4001EJ		4001EJ		1/1/77	
141		4001EK		4001EK		1/1/77	
142		4001EL		4001EL		1/1/77	
143		4001EM		4001EM		1/1/77	
144		4001EN		4001EN		1/1/77	
145		4001EO		4001EO		1/1/77	
146		4001EP		4001EP		1/1/77	
147		4001EQ		4001EQ		1/1/77	
148		4001ER		4001ER		1/1/77	
149		4001ES		4001ES		1/1/77	
150		4001ET		4001ET		1/1/77	
151		4001EU		4001EU		1/1/77	
152		4001EV		4001EV		1/1/77	
153		4001EW		4001EW		1/1/77	
154		4001EX		4001EX		1/1/77	
155		4001EY		4001EY		1/1/77	
156		4001EZ		4001EZ		1/1/77	
157		4001FA		4001FA		1/1/77	
158		4001FB		4001FB		1/1/77	
159		4001FC		4001FC		1/1/77	
160		4001FD		4001FD		1/1/77	
161		4001FE		4001FE		1/1/77	
162		4001FF		4001FF		1/1/77	
163		4001FG		4001FG		1/1/77	
164		4001FH		4001FH		1/1/77	
165		4001FI		4001FI		1/1/77	
166		4001FJ		4001FJ		1/1/77	
167		4001FK		4001FK		1/1/77	
168		4001FL		4001FL		1/1/77	
169		4001FM		4001FM		1/1/77	
170		4001FN		4001FN		1/1/77	
171		4001FO		4001FO		1/1/77	
172		4001FP		4001FP		1/1/77	
173		4001FQ		4001FQ		1/1/77	
174		4001FR		4001FR		1/1/77	
175		4001FS		4001FS		1/1/77	
176		4001FT		4001FT		1/1/77	
177		4001FU		4001FU		1/1/77	
178		4001FV		4001FV		1/1/77	
179		4001FW		4001FW		1/1/77	
180		4001FX		4001FX		1/1/77	
181		4001FY		4001FY		1/1/77	
182		4001FZ		4001FZ		1/1/77	
183		4001GA		4001GA		1/1/77	
184		4001GB		4001GB		1/1/77	
185		4001GC		4001GC		1/1/77	
186		4001GD		4001GD		1/1/77	
187		4001GE		4001GE		1/1/77	
188		4001GF		4001GF		1/1/77	
189		4001GG		4001GG		1/1/77	
190		4001GH		4001GH		1/1/77	
191		4001GI		4001GI		1/1/77	
192		4001GJ		4001GJ		1/1/77	
193		4001GK		4001GK		1/1/77	
194		4001GL		4001GL		1/1/77	
195		4001GM		4001GM		1/1/77	
196		4001GN		4001GN		1/1/77	
197		4001GO		4001GO		1/1/77	
198		4001GP		4001GP		1/1/77	
199		4001GQ		4001GQ		1/1/77	
200		4001GR		4001GR		1/1/77	
201		4001GS		4001GS		1/1/77	
202		4001GT		4001GT		1/1/77	
203		4001GU		4001GU		1/1/77	
204		4001GV		4001GV		1/1/77	
205		4001GW		4001GW		1/1/77	
206		4001GX		4001GX		1/1/77	
207		4001GY		4001GY		1/1/77	
208		4001GZ		4001GZ		1/1/77	
209		4001HA		4001HA		1/1/77	
210		4001HB		4001HB		1/1/77	
211		4001HC		4001HC		1/1/77	
212		4001HD		4001HD		1/1/77	
213		4001HE		4001HE		1/1/77	
214		4001HF		4001HF		1/1/77	
215		4001HG		4001HG		1/1/77	
216		4001HH		4001HH		1/1/77	
217		4001HI		4001HI		1/1/77	
218		4001HJ		4001HJ		1/1/77	
219		4001HK		4001HK		1/1/77	
220		4001HL		4001HL		1/1/77	
221		4001HM		4001HM		1/1/77	
222		4001HN		4001HN		1/1/77	
223		4001HO		4001HO		1/1/77	
224		4001HP		4001HP		1/1/77	
225		4001HQ		4001HQ		1/1/77	
226		4001HR		4001HR			



TRI-CON ASSOCIATES, INC. CAMBRIDGE, MASSACHUSETTS		DATE: 9-12-74	DRN: <i>em</i>	TOLERANCES UNLESS OTHERWISE SPECIFIED:		REV	REMARKS		DATE
PART: SCHEMATIC-13 DISPLAY CONSOLE II RM61		DATE:	CKD:	FRACTIONAL	± 1/64				
MATERIAL:		DATE:	APP:	DECIMAL	± .005				
		DATE:	NO. REQ'D:	ANGULAR	± 1/4°				
		SCALE:	FINISH:	ALL EDGES .005/0.010 R					
				SURFACE FINISH 1257					
				NEXT ASSY					
JOB NO: C-129		REV	FINISH:						
DWG. NO. A-682									



UNLESS OTHERWISE SPECIFIED		CONTRACT NO. C-125	DATE
TOLERANCES		DRAWN <i>MD</i>	5-19-70
±	±	CHECKED	
±	±	MECHANICAL	
±	±	ELECTRICAL	
±	±	PROJ. APPD	
±	±	APPROVED	
CENTERS PERMISSIBLE		TIMING DIAGRAM	
DIMENSIONS IN INCHES		ELECTRON SPECTROMETER	
AND APPLY AFTER PROCESSING		SIZE CODE BODY NO.	
NEXT ASST. USED ON APPLICATION		C 730	
		SCALE	
		UNIT	
		SHEET	



COPY AVAILABLE TO DDC DOES NOT PERMIT FULLY LEGIBLE PRODUCTION

Tri-Con Associates		DATE	2-8-57
CONTRACT NO. C-101	DRAWN	56	56
CHECKED	MECHANICAL		
ELECTRICAL			
PROJ. APPD			
APPROVED			
BLOCK DIAGRAM		ELECTRON SPECTROMETER	
USE CASE EDIT NO.	C	731	
SCALE	1:1		